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THE FUTURE OF MAN AS AN INHABITANT OF THE EARTH*

KIRTLEY F. MATHER

I

During the first decade or two of the current century, geologists, astronomers and physicists engaged in many discussions concerning the future of the earth as an abode for life. Some believed that "the end of the world" was relatively close at hand; others that the prospect for the future was to be measured in terms of hundreds of thousands if not of millions of years. As usual in scientific circles there has emerged from the conflict of ideas during the years of discussion a general unanimity of opinion, and today the geologic outlook for the future of the earth is quite clear.

Since the turn of the century new methods of measuring the length of geologic time have been discovered and applied. New concepts of the nature and sources of energy have been proposed and tested. New data concerning astronomic space and the distribution of the stars have been secured. Innumerable details of earth history have been deciphered to give a trustworthy record of the changes which the earth and its inhabitants have undergone in the past. The key to unlock the secrets of the future is now available in this knowledge of the past, and with our present understanding of the processes of nature that key may be intelligently used. All the evidence combines to lead us unmistakably to the conclusion that for many scores if not for hundreds of millions of years to come the earth will continue to be a comfortably habitable abode for creatures like ourselves.

Surface temperatures of the earth, the most important item in any consideration of its long-range habitability, are determined by the receipt of solar energy distributed through atmospheric agencies. For any given area of land the annual contribution of heat from the earth's interior, hot though it may be, is just about equal to the warmth received from the sun in twenty minutes by an equal area in equatorial latitudes under a clear sky at mid-day. The nineteenth-century picture of an earth, initially fiery hot but progressively cooling so that yesterday it displayed a glacial climate and tomorrow it will be too frigid to support life, may now be thrown into the discard. The earth will "grow old and die" only

* Eighteenth Annual Sigma Xi Lecture, Columbus, Ohio, December 28, 1939.

as a result of failure to receive adequate supplies of radiant energy from the sun. The prospect that the sun will "burn itself out" in a decrepit old age is so remote as to baffle all attempts to date that untoward event even by those who are expert in the juggling of astronomic figures. Nor is there any likelihood that the space-relations between earth and sun will change appreciably within scores of millions of years to put the earth either too close to the sun or too distant from it for comfort.

The lurid pictures of a sudden catastrophic debacle resulting from collision with some other heavenly body—comet, planet, star, or what you will—are products of a vivid imagination wholly without foundation in astronomic fact or theory.

The only plausible alternative to the conclusion that earth and sun will continue the even tenor of their ways for an inconceivably long period of time is that the sun will some day imitate the super-novae occasionally detected among the stars and terminate the existence of the entire solar system by a gigantic explosion. Precisely one such super-nova has been observed within the galaxy of the Milky Way and several such in all the other galaxies of stars during the last few decades. The astronomers could, therefore, calculate for us the chances on a statistical basis that any individual star—the sun, for example—would suffer such a fate within any given period of time. The result would be a figure so infinitesimal as to set at rest the mind of even the most jittery of questioners. Pending the discovery of the kind of premonitory symptoms displayed by stars about to blow themselves to atoms, the best that can be done is to rest content in history. Since the earliest records of living creatures were left as fossils, if not indeed since the earliest sedimentary rocks were formed, the sun has faithfully maintained its energy output within a fairly narrow range and has given no evidence of any fluctuations that might suggest any significant change in its behavior.

The geologist may, therefore, turn with confidence from the long perspective of geologic past with its one-and-a-half to two billion years of recorded earth history to a similarly long prospect for the future. Time is one of the most overwhelming resources of our universe.

It should not be inferred, however, that the earth will continue in the future to display the same environmental conditions as those which we enjoy today. The history of mankind thus far has been enacted against a background that in the full perspective of earth history is truly extraordinary. The geologic period in which we live is a time of unusually rugged and extensive lands with notably varied climate ranging from the glacial cold of Greenland and Antarctica to the oppressive warmth and humidity of certain equatorial regions. Such conditions have apparently recurred many times at long-spaced intervals since the oldest known rocks were formed, but added together the time thus represented cannot be as much as a fourth of geologic time. Much more characteristic of earth history as a whole have been the conditions illustrated by those periods when corals thrived in shallow seas occupying the site of Baffin Land and North Greenland, and coal-forming plants flourished on Antarctica. The probability is strong that eventually, say in five or ten million years, the earth will display

again the physical conditions of many past geologic periods that were characterized by broad low lands, wide shallow seas and uniform genial climate.

But most of us have a greater interest in the next few centuries than in the subsequent millions of years. Minor changes in climate will doubtless occur just as they have in the last few thousand years. Unfortunately, or perhaps fortunately, there is no basis for prediction concerning their nature, whether for better or for worse. There is really no good reason for referring to the present as "a post-glacial epoch"; it may prove to be an interglacial epoch. But our ancestors weathered ice ages in the past and presumably we are better equipped for such contingencies than they were. Should the average annual temperature of the earth as a whole be reduced something like 10° Fahr. and remain at that lower level for a few millennia, it is likely that once more the greater part of Canada, the northern United States, and the Scandinavian countries would be buried beneath great ice sheets. But in consequence of the removal of water from the sea as vapor to form the snow to produce the glacial ice, considerable areas now shallowly submerged along the coastlines in middle and equatorial latitudes would emerge as dry land. Indeed, it is likely that the area of land suitable for human abode would be nearly or quite as great at the climax of a glacial period as it is today.

By the same token, the disappearance of existing bodies of glacial ice as a result of rapid amelioration of climate in the not-distant future would, if it occurred, be a decidedly mixed blessing. Return to the sea the water now imprisoned in the ice on the Arctic islands, Greenland and Antarctic, without any compensating changes in crustal elevation, and sea level would be raised 50 or 60 feet the world around. Considering the number of people who now work or sleep in buildings in metropolitan communities not over 50 feet above sea level, the importance of such a change is readily apparent.

But from the geologist's point of view these are relatively trivial matters. With due deference to the nature of the climatic variations and geologic changes which are certain to occur in the next few thousand years, there is nothing to be expected from such sources that would seriously deter the human species from maintaining a comfortable existence on the surface of the earth for an indefinitely long period of time—a period to be measured in millions rather than in mere thousands of years.

II

At last, it is generally understood that man is a part of nature. He may be something more than an animal (that depends largely upon definition), but he is none the less truly a part of the animal world. Like the other inhabitants of the earth, man is a product of evolutionary processes operating on this particular planet.

We may be the last product of the creative forces displaying themselves in the organic development taking place in this particular portion of the cosmos, but we have no reason to assume that we are the last achievement of those forces. Nor does the fact that man has arisen from a lowly origin through processes of evolution validate the optimistic inference that he will necessarily

continue his progress to ever higher levels of activity. Evolution does not guarantee progress; it merely guarantees change. The change may be for the better or the worse, depending upon the conditions of time and place and the vitality of the individuals concerned.

The pages of Mother Earth's diary reveal an amazing and thought-provoking record of the progress of living creatures throughout the long eras of earth history. Again and again, in the procession of the living, dynasties of animals or plants have arisen from a humble origin to a position of world supremacy, maintained for a comparatively brief period and then lost forever. Some have disappeared entirely as their paths have led them off into blind alleys. Others have sunk to a low level and have continued a degenerate existence to the present day. A few have given rise to other and more efficient forms of life which superseded their predecessors as leaders in the procession. Gradually we are discovering some of the reasons for success and failure along the path of life. Beyond question, man may profit from these experiences of the past, if he uses the intellectual and moral resources which are available for him.

From the point of view attained through knowledge of geologic life development, man has today a unique opportunity to gain continuing security for himself and his progeny on the face of the earth, but whether or not he takes advantage of that opportunity is to be determined largely by himself. So far as we can tell, man is the first animal possessing the power to determine his own evolutionary destiny, but there is nothing in the record which guarantees that he will use that power wisely.

The animal species that in the past have been able to maintain their existence for more than two or three million years are relatively few in number. Most of them were comparatively simple types belonging to the less highly organized branches or phyla of the animal kingdom. Many were inhabitants of the sea where environmental conditions were remarkably stable throughout long periods of time. Among placental mammals, the major subdivision of the vertebrates to which man belongs, there is no similar record of longevity. Except under extraordinary conditions of geographic isolation, no species of placental mammal has persisted more than two or three million years. No matter how successful it may have been temporarily in multiplying and spreading over the face of the earth, each has become extinct in a geologically brief span of time. Perhaps a half million years might appropriately be taken as the average "life" of a species in this group of highly organized and notably complex creatures.

But extinction does not necessarily mean failure; it has frequently indicated the acme of achievement. For example, some of the now extinct three-toed horses and four-toed camels passed on "the torch of progress" to their descendants, the one-toed horses and two-toed camels, and thus gained long-continuing security of their kind.

What then does the future hold for mankind? *Genus Homo* has already existed for three or four hundred thousand years; the species *Homo sapiens* has about fifty thousand years to its credit. If the average applies, we may expect nearly or quite a half million years more of existence for our kind and then either oblivion as we reach the end of a blind alley or progressive development

into some type of descendant better adjusted than we to the total environmental factors of the time.

III

But does the average apply? Must man exist from the scene through either of the doors, that which closed behind the dinosaurs and titanotheres or that which opened before the three-toed horses and notharctines?

Most creatures have gained security by specializing in adjustment of structure and habit to particular environmental conditions, whereas man is a specialist in adjustability of structures and habits to a variety of environments. No other vertebrate can live as can he on Antarctic ice cap, in Amazonian jungle, beneath the surface of the sea, or high in the air.

Furthermore, man is the world's foremost specialist in transforming environments to bring them within the range of his powers. Far more efficient than the beaver or the mound-building ant, he drains the swamp, irrigates the desert, tunnels the mountain, bridges the river, digs the canal, conditions the air in home, factory and office.

As a matter of fact, adjustability to environment is accomplished more by controlling surroundings than by modifying internal organs or essential functions of the body. When we ascend with Major Stevens into the stratosphere, or dive with Doctor Beebe 500 fathoms deep off Bermuda, or live with Admiral Byrd through the long night of Little America, we take along with us a sample of sea-level atmosphere and temperate climate which is our real environment in a situation otherwise unbearable. Fur-lined parkas and tropical linen suits are but a medium for ensuring an immediate environment as nearly as possible like that of middle latitudes when living in polar or equatorial surroundings.

But regardless of interpretation of procedure, the result is clear. Man has placed himself in control of external conditions to an extent immeasureably greater than has any other creature. He has practically "drawn the teeth" of environment.

Although we know little of the details, it is certain that most of the creatures of the past who "have had their day and ceased to be" were forced into extinction by changes of one sort or another in their environment, changes which came with such relative speed that they were unable to make adjustment to them in time. Man need have no fear on that score.

IV

It is, however, immediately apparent that man's conquest of his surroundings has resulted from his clever use of things. Unless there is a ceaseless flow of cotton, flax and wool, of coal, iron and petroleum, of copper, lead and tin, from ground to processing plant to consumer, he becomes a puny weakling. It is because he uses certain resources provided by his environment that he is freed from slavery to his environment. Are these resources adequate to keep him supplied with what he needs to maintain indefinitely the sort of existence to which he has accustomed himself?

There are two fundamental sources of the goods and the energy which man uses in the grim business of securing the sort of living which he apparently

desires. On the one hand there is the farm and the waterfall, on the other there is the mine and the quarry. Things which grow in the field or forest, and power produced by falling water are in the category of annual income. Now that scientific research has made available the limitless quantity of nitrogen in the air for use as fertilizer, the resources of the plant and animal kingdoms are renewable; we use them, but we need never use them up. In startling contrast the resources of the mineral kingdom are non-renewable; they are in the category of accumulated capital. Petroleum and coal, copper and iron, lead and vanadium, these and many other prerequisites of modern civilization have been accumulated by nature through hundreds of millions of years of geologic activity. Thanks to scientific research, man is exhausting that store of mineral wealth in a few hundred, or at most a few thousand years. That inescapable fact is at rock bottom one of the most fundamental causes of economic distress, of war between nations, and of strife between classes.

Fairly accurate estimates of the world stores of many non-renewable resources are now available. Take petroleum as an illustration. The known available reserves of petroleum beneath the surface of the United States total at present approximately 17 billion barrels.[1] Experts differ in their guesses as to the quantity of petroleum that may be discovered in the future in areas that have not yet been adequately explored with the drill or in known fields by discovery of deeper reservoirs not yet reached by the deepest wells in those fields. There are also many varying shades of optimism and pessimism concerning the possibility of increasing materially the percentage of recovery of the oil present in a reservoir rock when penetrated by drilling operations. Estimates of the quantity to be added to our petroleum reserves from these two sources range from 7 to 8 billion barrels to 15 or 20 billion. I would incline toward the larger figures, considering them as maxima which are extremely unlikely to be exceeded. On that basis, the present store of available petroleum beneath the surface of the United States is 25 to 35 billion barrels. That is only about thirty times the annual domestic consumption of petroleum in recent years. The average annual production of petroleum in the United States during the five years from 1934 through 1938 was almost one billion, one hundred million barrels,[2] and the 1939 production exceeds one and a quarter billion barrels. At the present rate of withdrawal, the domestic stores of this essential raw material would, therefore, be exhausted in less than a third of a century.

Data are not nearly so precise for the majority of foreign countries as for the United States. It is, however, fairly safe to conclude that the world stores of petroleum will last only something like 75 years at the present rate of withdrawal. With the possible exception of Mexico, no other country has been as successful as the United Seates in the atttempt to exhaust its petroleum resources in the shortest possible period of time, but rapid progress toward that result is now being made in many regions.

Lest we become too pessimistic in response to such unwelcome figures, we should promptly note that substitutes for petroleum are already known. Gasoline, fuel oil and lubricating oil can now be manufactured from coal and other rocks rich in carbon, by processes of hydrogenation and polymerization. These

are expensive processes and their products cannot now compete with the products from petroleum even in countries far removed, both geographically and psychologically, from the more productive oil fields.[3] They will, however, come into use more and more in the next few decades.

Enough bituminous and sub-bituminous coal is known to be available within the United States to meet the present annual demand for coal, plus enough to manufacture gasoline and fuel oil in sufficient quantity to meet current demands for at least two thousand years. In addition there is enough oil shalet—a rock rich in carbon but containing little or no oil—to meet present needs for petroleum products for at least three or four thousand years.

Although petroleum affords an excellent illustration of the relation of non-renewable resources to the activities of man, it is by no means typical of the items comprising nature's accumulated capital. For nearly all of the important non-renewable resources, the known world stores are thousands of times as great as the annual world consumption instead of less than a hundred times. But for the few which like petroleum are not known to be available in such vast quantities, the story is much the same. Substitutes are already known, or potential sources of alternative supply are already at hand, in quantities adequate to meet our current needs for at least two or three thousand years. There is, therefore, no prospect of the imminent exhaustion of any of the essential raw materials, so far as the world as a whole is concerned, provided our demands for them are not multiplied rapidly in the future.

That, of course, raises another question. Will the demand for non-renewable resources increase materially in the future and thus hasten their exhaustion? Recalling the fact that the human population of the earth has increased almost five-fold in number in the last three hundred years, we might well be fearful on that score. The study of current population trends, however, makes it readily apparent that the next few hundred years will by no means duplicate that record of the past. If present trends continue, the all-time maximum population of the United States will be attained about the year 1970 and will total little more than 150 million souls.[4] Thereafter, except for possible influx of immigrants from other countries, no further increase in numbers is to be expected.

Accurate figures are available for only a few other countries, such as England, France and Germany, but there is a strong probability that the all-time maximum for the "white" races will be reached during the last third of the twentieth century and for the entire population of the earth before the end of the twenty-first century. Although the human family has doubled its numbers since 1860, it is extremely unlikely that it will ever reach twice its present number of approximately two billion. The pressure of demand for non-renewable resources will not, therefore, become acute because of the increase in population in the near future. Mother Earth is a very wealthy benefactress, and our heritage of physical resources is far greater than ordinarily supposed.

There is, however, another reason why current consumption of non-renewable resources cannot be taken as the basis for computing the "life" of such stores of basic materials. The demand for automobiles, telephones, radios, airplanes, zippers, is today very unevenly distributed. Only a small fraction of the human population uses such things in any large amount. Other peoples are

beginning to demand them and will do so increasingly as they become acquainted with the "benefits of civilization." In a few decades, unless we return to savagery, the world demand for many non-renewable resources will be twice or thrice that of today.

Taking all these things into consideration, it would appear that world stores of needed natural resources are adequate to supply a basis for the comfortable existence of every human being who is likely to dwell anywhere on the face of the earth for something like a thousand years to come.

Even so, there may be found here an excuse for the policy of "grabbing while the grabbing is good," which motivates many individuals and nations at the present time. That excuse might, of course, be offset by the suggestion that there is no need to take thought for a morrow a thousand years hence, if we have any respect for the ingenuity of our remote offspring. There is, however, another phase of current trends in human history that should not be overlooked in this connection.

One hundred years ago, something like 80 percent of all the things man used had their source on farms; most of the energy used to do the work of the world came from the muscles of living beings and from falling water. Today only about 30 percent of the things man uses come from things that grow; most of the energy with which work is done comes from petroleum and coal. For a century or more, the policy has been to use relatively less of the annual income and more and more of the stored capital.

Now comes the change. Automobile steering wheels are made from soy beans, piano keys from cottage cheese; innumerable articles fashioned of plastics are produced in part from corncobs and alfalfa; multitudinous metal and rubber substitutes are synthesized from various farm crops. Energy is transmitted at high voltages for hundreds of miles from hydro-electric turbines. A considerable portion of the annual budget for research is being devoted to progress in the direction of using more of the renewable resources—man's annual income, and less of the non-renewable resources—nature's stored capital.

What this new policy will mean is readily apparent. With progress along such lines, the pressure for political control of metalliferous ore deposits, coal fields and oil pools is lessened. Much of the physical basis for international jealously is liquidated. At last the intelligence of science may make it truly practical to beat our "swords into ploughshares, our spears into pruning hooks."

Again comes the insistent question from the pessimistic critic. Is there land enough? Is there sufficient fertile soil to provide adequate food and in addition the plant materials for the ever-expanding chemical industries? And again we hear the same reply. Yes, there is enough and to spare. J. D. Bernal computes from apparently valid data that the cultivation of two billion acres of land by the methods now in vogue in Great Britain would provide an optimum food supply for the entire population of the earth. "Two billion acres is less than half the present cultivated area of four billion, two hundred million acres, itself hardly 12 percent of the land surface of the earth."[5] And in this calculation no account is taken of the increased yields that may confidently be expected from the continuing research of agronomists, plant breeders and experts in animal husbandry, not to mention recent developments in the new science of the soil-

less growth of plants. Evidently, the predictions of Malthus notwithstanding, mankind need have no fear that increasing populations will place an impossible burden upon the available sources of food. Human ingenuity, intelligent use of renewable resources, wise adjustment of structures and habits to environmental conditions, seem competent to dispel that dread shadow.

But these optimistic conclusions concerning the relation of man to the non-renewable and renewable resources essential for comfortable existence are based upon world statistics. Obviously they do not apply with equal force to the economy of individual nations. No nation, not even the Soviet Union, Brazil, or the United States of America embraces within its political frontiers a sufficient variety of geologic structures to give it adequate supplies of all the various metalliferous ores necessary as raw materials for modern industrial operations. The United States, for example, must import nickel, tin, antimony, chromium and platinum if American manufacturers are to use those metals in the fabrication of articles essential to what we are pleased to call the civilized way of life.[6] Likewise, no nation enjoys a sufficient variety of climatic conditions to permit all kinds of food-stuffs to be grown on its farms and fields or gathered from its forests, and to allow the growth of all the various plants contributing raw materials to industry. The United States, again the most significant example for us, is forced to import all the bananas, coffee, tea, camphor, coconuts, flax, jute, quinine, rubber and shellac, consumed in this country, either from foreign countries or its own over-seas possessions.[7] It is entirely possible that, within a few decades, substitutes of domestic origin may be available to take the place of many, or even all of such commodities or that plant breeders and agronomists may find a practical way of extending the geographical limits of some of the plants whose products are considered essential so that any nation occupying a large fraction of any continent may actually be self-sufficient. But for the present and probably for a long time to come it is evident that every nation is dependent upon may other nations for the raw materials that it needs for its own industrial prosperity.

Perhaps the most important fact concerning the life of man today is this fact of interdependence. No nation, community or individual can gain any lasting measure of security without taking that fact into consideration. The resources that man must utilize, if he wishes to eccape the fate of his less intelligent relatives now known only by their fossil remains, are unevenly distributed and locally concentrated. The techniques of discovering and utilizing them are now fairly well known, but satisfactory procedures for making them and their products available to all members of the human family are not close at hand.

The very solution of the physical problems which man encounters in his attempt to maintain his foothold upon the earth brings him all the more forcefully into bruising contact with psychical and spiritual problems that must also be solved if he is to continue his existence on this planet. The critical question for the twentieth century is: how can two or three billion human beings be satisfactorily organized for the wise use and equitable distribution of resources which are abundant enough for all but are unevenly scattered over the face of the earth? Clearly, the future of man depends upon finding and applying the correct answer to that specific but far-reaching question.

Man is not only a specialist in the art of coödinated activity, but the trend toward organization is recognizable in the entire development of cosmic administration. Electrons, neutrons and protons are organized into atoms, atoms into molecules, molecules into compounds; some of the compounds prove to be cells, and these are organized to form individual plants and animals. Latest of all in the history of creative evolution certain individuals have been organized into societies. Transcending all that has gone before is the development of human society, obviously the most difficult, but at the same time potentially the most glorious organization yet attempted.

Two antagonistic alternatives present themselves as possible bases for this organization. The issue between the two has never before been so clearly drawn as it is today. The social group, whether it be the family, the industrial or commercial company or the political unit, may be organized on the principle of regimentation, or it may be developed according to democratic principles. Both methods are being tried under a variety of conditions, and each has something to be said in its favor. But both cannot be equally conducive to the continuing existence of mankind. One or the other must be selected as the basis for the future security of man.

If regimentation be the choice, then the great mass of humankind must be trained for obedience—blind, unquestioning, but superbly skillful obedience. The educator becomes the intellectual and spiritual counterpart of the drill sergeant in the army. This is no menial task, nor is its objective a mean one. Skill is a commodity of which there is never likely to be an oversupply. On the other hand, if democracy be the choice, the great mass of humankind must be trained for wise, self-determined coöperation. Precisely those qualities of mind and heart which have long been extolled in Christian doctrine must be developed to the fullest possible extent. Not only skillfulness but also the ability to govern oneself, the eternal prerequisite for freedom, must be developed in each member of the group.

In so far as physical existence is concerned, there would seem to be little or no choice between these alternatives. Perhaps, human nature being what it is today, the regimentation of society may temporarily be the more efficient method. But the full circle of organic law embraces more than mere existence. From the continuity of the evolutionary process, there has emerged a creature who is aware of vivid values in life, that may be found beyond the goods necessary for comfortable existence. Ideas and ideals are powerful determining factors in the world today, and among them the ideal of freedom for the individual in the midst of social restraint is the most vital and compelling of all. Though it baffle our scientific tools for measurement, it is nonetheless a reality.

It is in the yearning for freedom, the love of beauty, the search for truth, the recognition of moral law and in the awareness of spiritual forces that human nature is distinguished from all other sorts of nature. Man shares with other animals the need for satisfactory economics, for adequate food and shelter, for the goods essential to existence, but his needs transcend these physical factors because his nature differs from theirs. Probably nine-tenths of all the words that have been used since the dawn of speech in reference to "human nature" have referred to those elements in the nature of man which are shared with

other animals rather than to those which are man's unique possession. It would be far better to concentrate upon the latter and thus to distinguish human nature from animal nature.

Regimentation may be good for man as an animal; through that type of social organization his need for goods may be efficiently supplied. But regimentation is certainly not good for human nature as thus distinguished. Experience verifies what wisdom foresees; regimentation stultifies the spirit, destroys personality, standardizes thought and action. Worst of all, regimentation means stagnation of the creative process and, as we have seen, stagnation among the more complexly organized vertebrates has led inevitably to extinction. If man attempts to live by bread alone, mankind commits collective suicide. Apparently the best and perhaps the only chance for mankind to succeed in the quest for security is through progress in the art of living on a high spiritual plane rather than through exclusive attention to the science of existence on a purely physical level.

V

To put this same thought in more specific terms, it means that coördinated activity directed toward efficient organization of individuals must become cooperative activity directed toward the enrichment of personality within an efficiently organized society. This requires both intelligence and good will.

Fortunately, these characteristics are uniquely developed in the species of placental mammal with which we are preëminently concerned. Man is a specialist in the use of both. The trend of the past 5,000 years may well continue, despite numerous temporary setbacks, throughout the next few centuries at least.

It is sometimes suggested that because man has specialized in brains, brains may cause his downfall, just as presumably the overspecialization in external armament contributed to the downfall of certain herbivorous dinosaurs. That argument by analogy is, however, heavily punctuated with fallacies. There is as yet no evidence that mankind is weighed down with a superabundance of intelligence. On the contrary, it is failure to act intelligently that endangers individuals and groups in the midst of competition. To see in advance the remote consequences of contemplated action is an ability which ought to be increasingly cultivated rather than scouted as a menace.

There seems to be no good reason why a sound mind should not be accompanied by a sound body. If the number of psychopathic individuals is increasing in this high-speed, technologic age, it is a challenge to be met not by bemoaning the imminent collapse of civilization but by intelligent adjustment of habits and activities to the new demand of the new times.

Once the commitment is made to the belief that the coöperative way of life offers the best chance for the future security of man as an inhabitant of the earth, the need is greater for intelligence to be used as a guide for good will, rather than for good will to be applied as a brake on any possible increase in intelligence.

The roots of self-centered individualism may be traced backward for at least six hundred million years in the record of geologic life development, whereas our heritage of social consciousness dates from a time only about sixty million years ago when gregarious instincts became clearly evident among placental mam-

mals. That trend is, however, especially apparent in the group from which mankind has stemmed.

Man is still in the stage of specific youth. His "golden age," if, any, is in the future rather than in the past. Human nature is still sufficiently plastic and pliable to permit considerable change, notably in this important area of attitudes and relationships wherein the increase of good will as a motive for action seems most likely to result in beneficial adjustments to the new factors in the environment.

In thus seeking a satisfactory coördination of intelligence and good will, it becomes necessary for research scientists to give more thought than has been customary in the past to the social consequences of their work. They share with statesmen, politicians, educators and all molders of public opinion the responsibility for determining the uses to which the new tools provided by scientific research are put. As scientists they should continue to seek truth regardless of its consequences and to increase human efficiency in every possible way, but as members of society, as individual representatives of a species seeking future security as inhabitants of the earth, they must also do their utmost to ensure wise use of knowledge and constructive application of energy.

There is a real difference between the so-called "social sciences" and the "natural and physical sciences" that has an important bearing here. It is not that there is anything "unnatural" about the social sciences. Man is a part of nature, and the study of human society is just as truly "natural science" in the real sense of the term as any other study. The difference arises from the peculiar factors and particular functions pertaining to the coöperative way of life. Whereas the scientific use of things may be achieved through the efforts of a very small minority of the citizens, provided with adequate facilities for research, the scientific organization of society in a democracy can be achieved only when the majority of its citizens have the scientific attitude toward social problems and act in accordance with that attitude of mind. In other words, only a few physicists, chemists and technologists are required for the mastery of our physical environment, but for victory in the struggle with ourselves every man must be his own sociologist.

Although this places upon the forces of education a Herculean task, it is not nearly so impossible an assignment as at first glance it might appear to be. In the first place, the responsibility upon the individual citizen is rarely that of designing a new social structure or charting a new program for society. Almost invariably it is his duty merely to select from many plans, programs or proposals the one that seems to him most likely to produce the most desirable results for all concerned. In the second place, scientific habits of mind have already been developed to a greater extent than is ordinarily recognized. The garage mechanic attacks the problem of a balky automobile in a truly scientific manner. The salesman uses psychology in planning his approach to a difficult prospect. The housewife thinks scientifically when about to concoct a new dessert or redecorate the living room. In most cases, it is only necessary to apply in the area of social relationships the same habits of mind that have been followed in the area of individual behavior.

(*Please turn to page 20*)

MINUTES OF THE MEETING OF THE EXECUTIVE COMMITTEE OF SIGMA XI, COLUMBUS, OHIO, DECEMBER 28, 1939

A stated meeting of the Executive Committee was held in the Hotel Deshler-Wallick in Columbus, Ohio, December 28, 1939. The meeting was called to order by President Baitsell at twelve noon. Present were: President Baitsell, Secretary Ellery, Treasurer Pegram, Professor Miller, Professor Lund, Mr. Davies; and, by invitation, President Karl T. Compton of M. I. T., chairman of the nominating committee; Professor H. Jermain Creighton, Swarthmore, chairman of the committee of Sigma Xi lectures; Dr. L. B. Wilson of Mayo, former president of the Society. Actions were taken and reports received as follows:

1. Results of Prior Actions of the Committee.

The secretary announced that, acting upon the authority of the committee,

a. The complete transactions of the Executive Committee from 1916 to 1936, inclusive, have been duplicated and indexed and permanently bound in two volumes. One of these volumes has been deposited in the office of the National Treasurer, and the other in the office of the National Secretary.

b. Two complete sets of the Sigma Xi Quarterly have been collected, indexed, and bound. One of these sets has been deposited in the office of the National Treasurer, and the other in the office of the National Secretary.

c. The history of the Society for its first fifty years, together with the National Constitution, are now available in pamphlet form at 5 cents a copy. The Secretary stated that since publication and up to the date of the meeting 1,230 copies have been sold.

2. Formal Printed Petitions.

The printed petitions for charters of chapters at the University of Southern California and the Virginia Polytechnic Institute, copies of which had been distributed to the members of the committee early in October, were presented to the committee for further action. It was

Voted: *a.* That the petition of the University of Southern California be presented to the Convention with recommendation for favorable action;

b. That the petition of the Virginia Polytechnic Institute be presented to the Convention with recommendation for favorable action.

3. Reports of Official Visitors.

Pursuant to the action of the committee at the April, 1939 meeting in Washington the president named official visitors as follows:

a. Oberlin College, Professor Cole of Wisconsin and Dr. Myers of Western Reserve.

b. Bryn Mawr College, Professor Woodruff of Yale and Mr. Ellery of Union.

The reports from the official visitors were presented to the committee for their consideration. After considerable discussion, it was

Voted: That further action in the case of both institutions be made a special order of business at the April, 1940, meeting of the committee.

It was further

Voted: That in the case of Bryn Mawr College a possible second visit and survey be left to the discretion of the President and Secretary and Treasurer.

(The reports are on file in the Secretary's offce.)

4. Reports of Unofficial Visitors.

At the spring 1939 meeting of the committee in Washington, the President was authorized to arrange for personal inspection of certain institutions to precede the usual survey made by official visitors. The institutions involved are:

a. Utah State Agricultural College.

Professor Anderson, who had fully expected to visit this institution on his way from California to Columbus for the December meeting of the committee, found at the last moment that it was impossible for him to leave Pasadena. The visit was, therefore, postponed until the spring.

b. The University of Vermont.

Mr. Ellery made a visit to the institution October 24, and presented a report.

After discussion, it was

Voted: That further action in connection with a possible petition for a charter for a chapter at the University of Vermont be postponed until the April, 1940, meeting.

(The report is on file in the Secretary's office.)

c. Vassar College.

This institution has not been before the Executive Committee for consideration and study. Some correspondence has passed between the Secretary and a group of science faculty at Vassar College with reference to the conditions which the Executive Committee requires should be found in an institution which is contemplating the presentation of a petition for a charter. Acting upon this correspondence the Secretary took the occasion of a trip to New York on official business to arrange for a conference with this group of the science faculty at Vassar, and presented a report.

No action was required, and none was taken.

d. Texas Technological College.

At the April, 1939, meeting of the committee, Professor Lund was asked to be prepared to make a report about the conditions at the institution at the spring 1940 meeting. Professor Lund stated that he would be prepared to make such a report at that time.

5. Educational Conditions at Certain Institutions Where There Are Chapters.

For some years educational conditions at certain institutions have been under study and discussion by the Executive Committee, particularly with reference to the effect of those conditions on the activities of the chapters of Sigma Xi at those universities. At the spring 1939 meeting, the President was empowered to appoint visitors to make official survey of the conditions. The visitors presented reports, which are on file in the Secretary's office. After discussion

It was

Voted: That the recommedations of the visitors be adopted, and that the President and Secretary formulate encouraging letters to the chapters at the institutions embodying the suggestions of the visitors.

6. Officers' Visits to Chapters.

The Secretary reported that some years ago the Executive Committee authorized the Secretary to take the initiative in arranging visits of officers to chapters, but that nothing definite had been done about such visits to date. It was suggested that the matter be brought up again at the spring (1940) meeting.

7. Report of the Committee on Quarterly.

Following the spring 1939 meeting of the Executive Committee, the President appointed a special sub-committee on the Quarterly, as follows: Dean F. K. Richtmyer of Cornell, chairman; Dr. Watson Davis of "Science Service"; and Professor Harold C. Urey of Columbia.

The sub-committee held a meeting in New York City in April, 1939, a report of which appeared in the June (1939) issue of the Quarterly. Considerable correspondence about this important subject passed between the members of the committee subsequent to that meeting. In August, 1939, a report was submitted for consideration of the Executive Committee:

(The report appears on page 40, this issue.)

It was

Voted: That, having heard the report of the Committee on Quarterly proposing plans for improvement of the journal, including the proposals to have an editor-in-chief and a board of associate editors, to publish in the Quarterly more survey articles in the various fields of science, and to pay appropriate honoraria to authors, the Executive Committee ask the Convention to approve these proposals in principle, and to empower the Executive Committee to proceed to put them into effect.

8. Report of the Committee on Membership Structure.

At the 39th Convention it was voted to authorize the President to appoint a committee to study the entire membership sructure of the Society of the Sigma Xi, and to make report, with recommendations, at some future convention. The President appointed as such committee: C. E. Davies, Chair-

man; R. T. Birge, F. B. Dains, P. H. Sharp, L. L. Woodruff, C. E. McClung and F. F. Dedrick.

This committee presented "An Introduction to a Study of the Effectiveness of the Present Membership Structure of Sigma Xi."

(The report appears on page 42, this issue.)

The members of the Executive Committee expressed to the Chairman of the committee on membership structure appreciation of this presentation of the problem which confronts the committee, and it was

Voted: To present the entire report to the Convention.

9. THE 1941 LECTURE SERIES.

a. The itineraries of the current series are presented in full in the President's Report.

b. Also in the President's Report is a comparison of the current series with those of the preceding three years.

c. Consideration was given to the question of continuing the series for 1941. It was

Voted: That the Sigma Xi series of lectures be continued for 1941 and that the President be empowered to appoint a committee to arrange the series. The President appointed such committee as follows: H. Jermain Creighton, Swarthmore, Chairman; L. A. DuBridge, Rochester, and H. C. Urey, Columbia.

10. THE PUBLICATION OF THE SERIES FOR 1939-40.

The President's Report includes a statement of the sales of *Science in Progress*, the volume in which the Sigma Xi lecture series for 1937 and 1938 are published. Considerable discussion followed regarding the publication of a second volume to include the 1939 and 1940 series. It was

Voted: To authorize the President and Secretary and Treasurer to arrange for the publication of a second volume of Sigma Xi lectures, to include the 1939 and 1940 series.

11. SIGMA XI PUBLICITY.

The Secretary presented a complete report from "Science Service," which included a statement of all the newspaper stories which that bureau had issued since April, 1939, the date when it was authorized to spend $200 for Sigma Xi publicity. Accompanying the report was a list of the newspapers to which news releases were regularly sent. The Secretary read letters from science editors of various newspapers requesting fuller statements of certain news items which had appeared in the public press about Sigma Xi.

The question was raised as to whether the Executive Committee would authorize a further appropriation of $200 for publicity purposes. It was

Voted: That the sum of $100 be appropriated at this time for use until the adoption of the budget for the year 1940 at the spring (1940) meeting of the Executive Committee.

12. Posthumous Elections.

The Secretary presented a letter from one of the chapters requesting the judgment of the committee on the matter of posthumous election to membership. The letter stated that the individual involved would have been presented to the membership committee of the chapter with recommendation for favorable action, but that the individual had died before the membership committee could take action. The committee instructed the Secretary to inform the chapter that the Executive Committee was confident that the chapter itself could best decide the appropriate action in the case, and that it was, therefore, prepared to leave the decision to the chapter.

13. Sigma Xi Status of Retired Faculty Members in Residence.

The Secretary presented a letter from a member of the faculty of an institution where there is a chapter, who had reached the retiring age, and was no longer to be active as a member of the staff of the institution. The letter was accompanied by the request for a definition on the part of the national organization of the individual's status in the chapter itself. The Executive Committee instructed the Secretary to state to the individual that while the constitution defines the membership of chapters as composed of members who are actively connected with the institution as students or members of the staff, a chapter may also include in its membership local members of the Society not actively connected with the institution and may place such affiliated chapter members on the chapter roll, may report them to the Secretary and the Treasurer of the Society as active members, may have them receive the Sigma Xi Quarterly, and extend to them all the privileges and duties of chapter members except the power of voting.

14. Officers' Reports.

(The Officers' Reports appear in full on pages 30, 33, and 35, in this issue.)

In connection with the Treasurer's Report, it was

Voted: To present to the Convention the following resolutions:

Resolved: That the annual assessment on each chapter for 1940 shall be payable on January 1, 1940, and that the amount of the assessment on each chapter shall be 75c, multiplied by the number of members and associates of the chapter on January 1, 1940.

Resolved further: That in sending notice of the 1940 assessment to chapter Treasurers, the Treasurer of the Society be instructed to advise each chapter that the assessment is to be computed strictly on the basis of the number of members and associates on the membership roll of the chapter, without regard to whether said members have or have not paid current chapter dues, and to explain that this method of fixing the amount of the assessment on each chapter has been adopted by the Convention of the Society as the most equitable to all chapters.

The Executive Committee also

Resolved, That the Society express to the Duke Chapter thanks on behalf of the Society for the gift of fifty dollars sent in March, 1939, toward the expenses of the lecture program of the Society.

15. ACTIVITIES OF PRESIDENT AND SECRETARY.

The President and Secretary asked the Executive Committee if it would approve their continuation in their respective offices until July 1, 1940, provided the expected report of the nominating committee was adpoted by the Convention. It was

Voted: *a.* That Professor Baitsell, while officially Secretary of the Society, would be Acting President until July 1, 1940.

b. That Professor Ellery, while officially President of the Society, would be Acting Secretary until July 1, 1940.

EDWARD ELLERY, *Secretary.*

The Future of Man as an Inhabitant of the Earth

(*Concluded from page 14*)

VI

In conclusion, the outlook for the future of man as an inhabitant of the earth is far from pessimistic. If certain tendencies already developing are encouraged and certain resources already available are capitalized to the full, there is good reason to expect that mankind will maintain existence and even live happily for an indefinitely long period of time. The opportunity is his to demonstrate the intrinsic worth of biologic phenomena and thus to justify the vast expenditure of time and energy involved in organic evolution. With greater emphasis upon the development of intelligence and good will, he may achieve that which the temporarily triumphant dynasties of the past have failed to achieve. Thus the geologist may turn from the long perspective of geologic history to the enticing vista of the geologic future of earth and man with high hope and even with confident assurance.

REFERENCES

[1] "Petroleum Reserves Are Estimated by Institute Committee at New Record Total," American Petroleum Institute Quarterly, Vol. 9, No. 2, p. 7, 1939.

[2] Statistics from Minerals Yearbook, published annually by the United States Bureau of Mines.

[3] K. C. Heald, "Technology and the Mineral Industries," WPA National Research Project, Report E-1, pp. 27-31, 1937.

[4] Thompson and Whelpton, National Resources Committee, Population Statistics, Vol. 1, "National Data," p. 9, 1937.

[5] J. D. Bernal, "The Social Function of Science," New York, 1939, p. 347.

[6] Brooks Emeny, "The Strategy of Raw Materials," New York, 1937, p. 26 and chart facing p. 29.

[7] *Ibid.*, pp. 26-37.

THE FORTIETH ANNUAL CONVENTION

The Fortieth Convention of the Society of the Sigma Xi was held in the Hotel Deshler-Wallick, Cleveland, Ohio, December 28, 1939.

1. CALL TO ORDER.

The business session was called to order at 4.00 P.M. by the President, Professor George A. Baitsell of Yale University.

2. COMMITTEE ON CREDENTIALS.

The President announced a Committee on Credentials, as follows:

Dr. William H. Cole, Rutgers, Chairman.
Dr. William Pietenpol, Colorado.
Dr. Clarence E. Bennett, Maine.

3. REPORT OF THE COMMITTEE ON CREDENTIALS.

The Committee received the credentials of the delegates, and reported that 59 chapters (with 78 delegates) and 14 clubs (with 20 delegates) were represented as follows:

a. Chapters represented by delegates present and voting (the list is alphabetical, not chronological):

Alabama—Julian D. Mancill, C. M. Pomerat
Arizona—C. T. Vorhies
Buffalo—O. W. Richards, A. R. Shadle
Carleton—Edward A. Fath. C. Grace Shover
Carnegie—Joseph Rosenbach
Case—Richard S. Burington
Cincinnati—S. B. Arenson
College of Medicine, University of Illinois—I. Schour
Colorado—William Pietenpol, Edna Johnson, Francis Ramaley
Columbia—Harold W. Webb
District of Columbia—Charles A. Browne, Walder D. Lambert
Duke—Bert Cunningham
Florida—T. H. Hubbell
George Washington—Lawson E. Yocum, Francis E. Johnston, Robert C. Grubbs
Harvard—A. B. Dawson
Idaho—Walter Virgin
Illinois—W. V. Balduf
Indiana—C. M. Louttit
Iowa—E. W. Chittenden, J. H. Bodine
Iowa State—D. L. Holl
Kansas—W. H. Horr, F. E. Kester
Kansas State—Mary T. Harman, G. A. Filinger
Kentucky—L. A. Pardue, Stephen Diachun, Lee H. Townsend
Massachusetts Institute of Technology—Karl T. Compton
Massachusetts State—O. C. Boyd, J. K. Shaw
Mayo—L. B. Wilson
Michigan—R. A. Sawyer
Michigan State—R. Hutson
Minnesota—Dwight Minnich
Missouri—E. S. Haynes
Nebraska—W. C. Brenke
New York—Carl J. Sandstrom
North Carolina—R. E. Coker
Northwestern—C. D. Turner
Ohio State—W. C. Fernelius
Oklahoma—M. Hopkins
Oregon—R. R. Huestis
Pennsylvania—H. H. York
Pittsburgh—O. H. Blackwood
Princeton—Arthur K. Parpart
Rensselaer—R. A. Patterson
Rice—C. W. Heaps
Rochester—Russell A. Wilkins
Rutgers—William H. Cole, W. Rei Robbins
Smith—Robert F. Collins, Myra Johnson
State College of Washington—R. F. MacLennan
Swarthmore—H. Jermain Creighton
Syracuse—N. Artz
Texas—T. S. Painter
Tulane—Harley N. Gould
Union—Edward Ellery
University of Washington—Herbert P. Riley
Virginia—Gordon T. Whyburn
Wellesley—Louise S. McDowell
Western Reserve—H. S. Booth, J. P. Visscher, J. C. Gray
West Virginia—L. M. Peairs, L. G. Leach
Wisconsin—J. G. Winans
Wyoming—Aven Nelson
Yale—W. W. Watson

b. Chapters which had named delegates, but were not reported as represented:

California at Los Angeles
Wesleyan

c. Chapters which had not named delegates, and were not reported as represented:

Brown
California
California Institute of Technology
Chicago
Cornell
Johns Hopkins
Lehigh
Maryland
McGill
North Dakota
Oregon State
Pennsylvania State
Purdue
Stanford
Utah
Washington University
Worcester

d. Clubs represented:

Bucknell—W. H. Eyster
California at Davis—Warren P. Tufts, E. E. Wilson
Colorado State—Dudley Glick
Georgia—A. S. Edwards
Louisiana State—Jean Dufrenoy, William V. Parker
Maine—Clarence E. Bennett
Mississippi—J. D. Evans
North Dakota Agriculture—E. A. Helgeson
Ohio—F. H. Krecker
Oklahoma A. and M.—F. E. Fenton, J. C. Ireland
Southern California—Harry J. Deuel, Jr., Francis Marsh Baldwin
Utah State—F. B. Wann
Vermont—George P. Burns, Ralph M. Holmes, Paul A. Moody
Virginia Polytechnic—George Harrar

e. Officers present:

President Baitsell, Secretary Ellery, Treasurer Pegram, Professor Miller, Professor Lund, Mr. Davies.

[The secretary appends to the report of the Committee on Credentials the following record of attendance at the last five conventions:

	Chapters present and voting	*Total number of chapters*	*Clubs present*	*Total number of clubs*
1935	52	66	12	36
1936	46	68	7	34
1937	56	72	10	34
1938	44	76	11	37
1939	59	78	14	38

4. MINUTES OF THE THIRTY-NINTH CONVENTION.

The account of the proceedings of the Thirty-ninth Convention of the Society, held in Richmond, Virginia, December 28, 1939, as published in the March, 1939, QUARTERLY, was approved as printed.

5. PETITIONS FOR CHARTERS FOR CHAPTERS.

a. The Executive Committee presented a printed petition for a charter for a chapter at the University of Southern California. The Secretary stated that the petition had been distributed among the chapters the first week in November, that the institution had been under study by the Executive Committee for some years, that the official visitors appointed to make personal survey of the equipment and resources were Doctor Durand and Dean Pegram, and that the report of the official visitors recommended the granting of the charter. Dean Pegram, one of the official visitors, presented a résumé of the official visitors' report. The President stated that the Executive Committee presented the petition to the Convention with recommendation for favorable action. After some discussion on the part of the delegates, it was

Voted: Almost unanimously that the Secretary be authorized to cast a ballot in favor of granting the petition. The Secretary announced that the

ballot had been cast, and the President followed with the announcement that the petition was therefore granted.

b. The Executive Committee presented a printed petition for a charter at the Virginia Polytechnic Institute. The Secretary stated that the petition had been distributed among the chapters the first week in November, that the institution had been under study by the Executive Committee for some years, that the official visitors appointed to make personal survey of the equipment and resources were Doctor Durand and Mr. Davies. Doctor Durand was unable to make the visit. The report of Mr. Davies recommended the granting of the charter. Mr. Davies presented a résumé of the report. The President stated that the Executive Committee presented the petition to the Convention with recommendation for favorable action. After some discussion on the part of the delegates, it was

Voted: By almost unanimous vote that the petition for a charter for a chapter of Sigma Xi at the Virginia Polytechnic Institute be granted.

6. REPORT OF THE COMMITTEE ON QUARTERLY.

(See Executive Committee minutes on the same subject.)

The Executive Committee presented the following resolutions to the Convention:

(See Executive Committee minutes on the same subject.)

It was

Voted: To approve the recommendations of the Executive Committee regarding the immediate future of the QUARTERLY.

7. THE REPORT OF THE COMMITTEE ON MEMBERSHIP STRUCTURE.

(See Executive Committee minutes on the same subject.)

Attention was called to the action of the Thirty-ninth Convention, authorizing the President to appoint a committee to study the membership structure of the Society, and to make report at some future Convention. Mr. Davies, Chairman of the Committee on Membership Structure, read to the Convention the report which he had previously presented to the Executive Committee. It was

Voted: To thank the committee for this complete presentation of the problem, and to accept the report as given.

8. REPORT OF THE PRESIDENT.

(See page 30, this issue.)

9. REPORT OF THE SECRETARY.

(See page 33, this issue.)

10. REPORT OF THE TREASURER.

(See page 35, this issue.)

The following recommendation from the Executive Committee was unanimously adopted:

Resolved: That the annual assessment on each chapter for 1940 shall be payable on January 1, 1940, and that the amount of the assessment on each chapter shall be 75 cents, multiplied by the number of members and associates of the chapter on January 1, 1940.

Resolved further: That in sending notice of the 1940 assessment to chapter treasurers, the Treasurer of the Society be instructed to advise each chapter that the assessment is to be computed strictly on the basis of the number of members and associates on the membership roll of the chapter, without regard to whether said members have or have not paid current chapter dues, and to explain that this method of fixing the amount of the assessment on each chapter has been adopted by the Convention of the Society as the most equitable to all chapters.

11. Election of Officers.

The Committee on Nominations was as follows:

Dr. Karl T. Compton, M. I. T., Chairman.
Professor P. H. Mitchell, Brown.
Dean F. K. Richtmyer, Cornell (deceased since appointment, but the report had had his approval).

The following officers were proposed:

President—Edward Ellery, Union College.
Secretary—George A. Baitsell, Yale University.
Executive Committee—Harvey E. Jordan, University of Virginia.
Alumni Committee—C. E. Davies, Rensselaer, for one year, in place of Dr. Florence R. Sabin;
John C. Parker, Michigan, for five years.

It was

Voted: To adopt the report of the Nominating Committee as presented by its chairman, President Compton, and to declare the nominees elected to their respective positions as named.

The Chairman of the Nominating Committee called the attention of the Convention to a vacancy in the *ex officio* membership of the Executive Committee, namely, that of the retiring president. The constitution provides that the retiring president shall continue as an *ex officio* member of the Executive Committee for the two years following his retirement from office. Since President Baitsell, by the preceding vote of the Convention, becomes the Secretary of the Society, and hence a member of the Executive Committee, upon the recommendation of the Nominating Committee, it was

Voted: To ask Doctor Durand to continue in office as *ex officio* member of the Executive Committee for the ensuing two years.

12. Adjournment.

The meeting was adjourned at 5.45 P.M.

THE OFFICERS' DINNER

Following the Convention the officers of Sigma Xi were hosts to the officers of the A. A. A. S. and a few other invited guests, at a dinner in honor of Professor Mather, the eighteenth annual Sigma Xi lecturer. The dinner was held in the Hotel Deshler-Wallick at 6.30 P.M., and the thirty-eight who were present included some of the delegates to the Convention who had purchased dinner tickets.

THE EIGHTEENTH ANNUAL SIGMA XI LECTURE

The eighteenth annual Sigma Xi lecture was given in Memorial Hall at 8.30 P.M., December 28, by Professor Kirtley F. Mather of Harvard University, on the topic, "The Future of Man as an Inhabitant of the Earth." The officers of Sigma Xi and their guests were seated on the platform, which had been tastefully decorated with palms and poinsettias by a local florist, and the Sigma Xi seal and motto was suspended in the center of the stage. It was estimated that there were some 700 in the audience. President Baitsell presented Professor G. H. Parker, former President of Sigma Xi and a colleague of Professor Moulton, who introduced the lecturer. The lecture appears in full in this issue of the QUARTERLY.

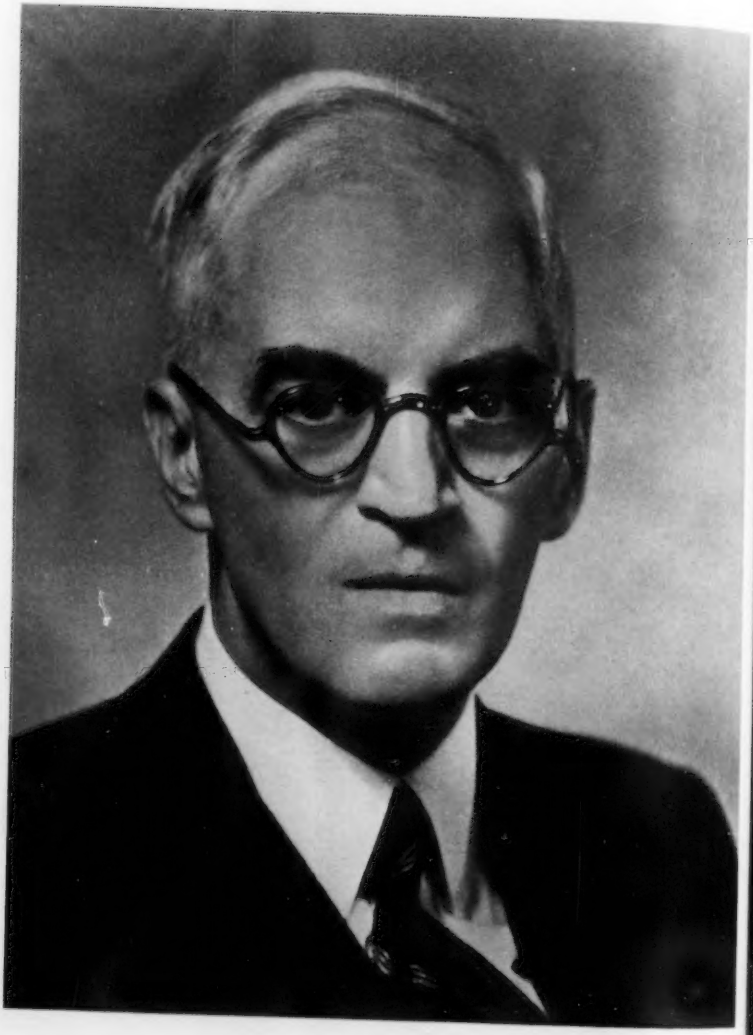
EDWARD ELLERY, *Secretary.*

HARVEY ERNEST JORDAN

THE NEW OFFICERS

DR. HARVEY ERNEST JORDAN

Dr. Harvey Ernest Jordan, chosen by the Fortieth Convention of the Society as a member of the Executive Committee for the ensuing five-year term, is the Dean of the Department of Medicine at the University of Virginia. He was a charter member of the Virginia Chapter and has been active in chapter affairs from the beginning of its history, serving as its president during one of the early years. Dean Jordan received the Bachelor's degree from Lehigh and the Doctorate from Princeton. He has been associated with the University of Virginia since 1907 as adjunct and associate professor of anatomy, professor of histology and embryology, professor of anatomy and director of the anatomical laboratories, and assistant dean of the Department of Medicine. He became dean of the department in June, 1939. He has had broad experience in research work in his chosen fields, at the Carnegie Institution, the Marine Biological Laboratory at Woods Hole, in the laboratory at Tortugas in Florida, and the Mantego Bay laboratory. He has served on the advisory council of the U. S. Eugenics Commission, has been associate editor of the *Journal of Morphology and Physiology*, and associate editor, *Folia Haematologica*. He is president of the American Microscopical Society. Many published articles cover his research results over a broad field. His term of office as a member of the Executive Committee of the Society of Sigma Xi continues to January, 1945.



JOHN C. PARKER

JOHN C. PARKER

John C. Parker was elected by the Fortieth Convention of the Society as a member of the Alumni Committee for the ensuing five-year term. He is vice-president of the Consolidated Edison Co. with office in New York, New York. He was made a member of the Society of Sigma Xi by the Michigan Chapter where he had previously received the degrees of Bachelor of Science, Master of Science and Electrical Engineer. He was made Doctor of Engineering by Stevens Institute in 1935. Prior to his connection with the Consolidated Edison Co. he filled engineering positions with the Ontario Power Co., Niagara Falls; Niagara, Lockport and Ontario Power Co., Buffalo; Rochester Gas and Electric Co., and the Brooklyn Edison Co. He shared his practical engineering experience with undergraduates at Union College where he was an instructor in electrical engineering, and at the University of Michigan where he was professor in charge of electrical engineering. He thus brings to the important work of the Sigma Xi Alumni Committee a wide experience in one of the great fields of applied science which Sigma Xi represents and a broad acquaintance with men in that field who are extending the range of technical knowledge and invention.

REPORT OF THE PRESIDENT FOR 1939

1. It is with unusual sadness that the death of Dean Floyd K. Richtmyer is announced to the Convention and the Society at large. Investigator, author, university professor and dean of the graduate school, Dean Richtmyer was well known in academic and scientific circles in this country and abroad.

His research and study of X-ray phenomena gave him an international reputation. His "Introduction to Modern Physics" was widely used. He was identified with the National Research Council from its foundation, and was chairman of its division of physical sciences. He served the United States Bureau of Standards as physicist, was an investigator in the research laboratory of the General Electric Co., and during the World War was a radio engineer in the Signal Corps of the United States Army.

From the time of his election as a member of the Society of the Sigma Xi in his graduation years at Cornell in 1904, his interest in the purpose of the Society and his active participation in the great forward movements of the national organization were continuous. He served Sigma Xi as a member of the National Executive Committee, as the National President, and as Chairman of the Committee on Constitutional Revision in 1922, and during the current year as chairman of the committee on the important work of perfecting the editorial management of the SIGMA XI QUARTERLY, and a member of the Nominating Committee.

Dean Richtmyer will be profoundly missed in the councils of Sigma Xi and in educational and scientific circles everywhere, in this country and in a large area in Europe.

2. The President is privileged to announce the first scientific publication of our great Society, under the title of "Science in Progress." It has a foreword by Professor Harlow Shapley of Harvard, and contains the lectures of the first two of the national Sigma Xi lecture series. There are chapters by Ernest O. Lawrence, Harold C. Urey, W. M. Stanley, L. O. Kunkel, Karl E. Mason, R. R. Williams, Edgar Allen, Theophilus S. Painter, E. Newton Harvey and Francis G. Benedict. It is with great pride that we can say that among the contributors to our first scientific publication are two Nobel laureates, Professor Urey and Professor Lawrence. At the time of its publication the book was declared to be the leading scientific publication of the month by the "Science Book of the Month Club." It was issued in April, in an edition of 2,049 copies. To date 1,141 copies have been sold, of which 246 went through the office of the National Secretary.

A considerable number of chapters and clubs have purchased the book as a gift to the library of their institution. It is difficult to conceive of a better way of advancing the cause of Sigma Xi—the promotion of research—than by making such an important scientific publication available to students and faculties of our educational institutions. Chapters and clubs which have not already done so are urged to consider favorably such a gift to their institutions.

3. Arrangements are now completed for the fourth of the series of Sigma Xi national lectures. The lecturers and their topics, and the institutions before which they will appear, are as follows:

Prof. J. W. Beams—"High Speed Centrifuging."

McGill University
University of Michigan
College of Medicine, University of Illinois
University of Wisconsin
University of Idaho
Carnegie Institute of Technology

Dr. J. F. Fulton—"The Functions of the Frontal Lobe; an Experimental Analysis in Monkeys, Chimpanzees and Man."

University of Vermont
University of Washington
State College of Washington
Stanford University
Mayo Foundation
Beloit College
Univeritysof Illinois
College of Medicine, University of Illinois
Northwestern University
Swarthmore College

Prof. Douglas Johnson—"Mysterious Craters of the Carolina Coast."

Swarthmore College
University of Maine
Denison University
University of Illinois
Indiana University
The Rice Institute
University of Kansas
Louisiana State University
University of Nebraska
Northwestern University

Dr. D. A. MacInnes—"The Motions of Ions and Proteins in Electric Fields."

Swarthmore College
State College of Washington
University of Washington
Oregon State College
Brigham Young University
University of Wisconsin
State University of Iowa
College of Medicine, University of Illinois
Western Reserve University

Prof. F. W. Went—"The Regulations of Plant Growth."

Lehigh University
Bucknell University
University of North Carolina
Emory University
Tulane University
Louisiana State University
Mississippi State College
Washington University
College of Medicine, University of Illinois
Indiana University
Western Reserve University
University of Cincinnati
The Mayo Foundation
University of Colorado
Utah State Agricultural College

There is thus a total of fifty engagements for these five lecturers. The record for the three preceding years is:

1937—27. 1938—31. 1939—39.

4. During the year two additional chapters have been installed by the President and Secretary—one at the University of West Virginia in March, and one at the University of Alabama in April. This brings the chapter total to seventy-eight, with an active enrollment of something like 16,000. The Convention will be asked today to act on two other petitions, which were distributed to the chapters November 1—the University of Southern California, and the Virginia Polytechnic Institute.

There are now six institutions under survey with reference to possible petitions for charters for chapters at some future Convention.

5. Four new clubs have been added to the roster of Sigma Xi clubs during the year, Emory University, North Carolina State College, The University of Hawaii and Mississippi State College, making a total of thirty-eight clubs. A Sigma Xi club is composed of members and associates of Sigma Xi who are connected with an institution or resident in a community. There must be a

minimum of twelve members or associates in the enrollment of the club before it is authorized, at least two meetings a year must be held which are attended by not less than ten of the membership, and the club is required to make annual report of its activities to the National Secretary. These clubs are active science organizations within the institution with which they are for the most part connected. It is impressive to note that nine of the clubs have this year engaged one or more of our Sigma Xi lecturers.

6. There have been added during the academic year 1938-39 approximately 700 members and 1,400 associates.

7. The committee of award of Sigma Xi grants-in-aid awarded for the current academic year the sum of $2,180 to twelve applicants—six in biology, two in astronomy, two in geology, and two in medicine.

8. a. During the year the minutes of the transactions of the Executive Committee, from its first meeting in 1916 to and including 1936, have been bound in permanent forms. A complete index has been made of the transactions. There are two copies of the volume—one deposited with the Treasurer of the Society, and one with the Secretary.

b. The Society now has two complete sets of the SIGMA XI QUARTERLY, including the first volume published in 1913, and the last volume published in 1939. These are completely indexed, and bound in permanent form. There are seven volumes in each set.

c. During the year the Society published the history and constitution of Sigma Xi in pamphlet form, for possible presentation to newly elected members and associates, and for information of the many inquirers about the organization from various quarters. The pamphlet retails at five cents, and since its publication, 1,230 copies have been distributed. It is suggested that chapters may wish to provide themselves with copies for presentation to the spring initiates.

GEORGE A. BAITSELL, *President.*

REPORT OF THE SECRETARY FOR 1939

"Sigma Xi is a living organism. The march of events indicates that the founders builded well. The growth in numbers and in influence during the years has been gradual but constant. That is the way things grow that are sure to endure."

So wrote the present Secretary eighteen years ago in the SIGMA XI QUARTERLY for March, 1922, when he succeeded the great Doctor Ward in office. What had the Society grown from? What had it grown to in 1922? In 1903, eighteen years before the Secretary so expressed himself, there were seventeen chapters of the Society of the Sigma Xi. There was no SIGMA XI QUARTERLY. The Society's activities were limited to chapter meetings, whose chief interest was electing new members, and the organization of new chapters in educational institutions. Printed records do not show what the finances of the Society were in 1903, but ten years later, eight years before the Secretary wrote, the total receipts were $350, and the total expenses $160. In 1913 there were 466 active members, and the total membership—which included those who were no longer connected with chapters—was 7,500. In 1913 the SIGMA XI QUARTERLY was born, and during that year amassed a subscription list of 1,700.

Now come to the year in which the Secretary expressed himself as above.

In 1922 it was reported that the total receipts of the Society had increased from $350 to slightly over $2,200. The total expenses had risen from $160 to slightly over $2,100. The number of chapters had increased from seventeen to thirty-nine. The active membership list mounted to 3,000, and the total membership to well over 15,000. Sigma Xi had given abundant evidence eighteen years ago that it was a living organization.

In this eighteenth annual report of the present Secretary, he repeats what he stated eighteen years ago, "The Society of the Sigma Xi is a living organism." That is the reason why the annual reports of its officers are not mechanical or repetitive. A growing thing cannot be reduced to a formula. Here is what Sigma Xi has grown to since 1922. The total receipts in 1938 were over $19,000. The total expenses for that year were just under $15,000. In 1938 there was an active membership of close to 15,000, and a total membership of well over 40,000, found in fifty-five different countries of the world. The SIGMA XI QUARTERLY, which in 1913 had a subscription list of 1,700, went out this month, December, 1939, to approximately 18,000. In 1911 the Society published a "Quarter Century Record and History" of 542 pages. In 1936 the Society published a "Half Century Record and History" of 1,208 pages.

The activities, both of chapters and the national organization, have shown impressive expansion in the last eighteen years. Many chapters now give prizes for research work. Some have established research fellowships. In 1921 the national organization began its grants-in-aid movement, and between 1921 and 1938 distributed almost $36,000 in the form of grants-in-aid to 131 candidates: Biology (including Psychology) 74, Chemistry 13, Physics 16, Sciences of the Earth 13, Astronomy 8, Medicine 7.

In 1927 the Society began the accumulation of a permanent fund, with a sum just under $5,000. In 1938 this fund amounted to slightly over $36,500. The Society has established a Semi-Centennial fund, amounting at present to $15,000. The income from these permanent funds added to annual contributions from the so-called Sigma Xi alumni (that is, those who are no longer connected with active chapters) are used by the Society in support of grants-in-aid and prizes in recognition of research accomplished.

Here are some other movements of the present Sigma Xi which the Sigma Xi of eighteen years ago did not know:

1. Individuals who have by actual work of investigation exhibited their aptitude for scientific research, although not connected with institutions where there are chapters, are now eligible to membership.

2. Our Society presents a lecturer at the December meetings of the A. A. A. S. Professor Mather, the lecturer this year, the eighteenth of the series, is one of a brilliant group of scientists who have represented the Society and the cause of research in this important event of the winter science meetings.

3. The Society maintains a series of lectures by distinguished scientists of the country on the most recent work in special fields of scientific research, and among the lecturers are two Nobel laureates. The present series is the fourth, and the lecturers are such widely known scientific leaders as F. W. Went, J. F. Fulton, J. W. Beams, Douglas Johnson and D. A. MacInnes. They will deliver a total of fifty lectures during the coming months in thirty-six institutions from Maine to California.

4. The Society has entered the field of scientific publications. Last spring the first two series of Sigma Xi national lectures appeared in book form under the appropriately descriptive title "Science in Progress." The book was edited by the President of Sigma Xi, was published by the Yale University Press, and its sales to date have totalled 1,141 copies.

"The Society of the Sigma Xi is a living organism." What will the Secretary report eighteen years from now? Here are some possibilities:

1. Chapters in foreign universities. This is no idle dream. If the world of human beings ever comes to stable living conditions and recognizes and encourages the enormous value to the progress of civilization of the constantly open and free mind of intelligent men, the Society of the Sigma Xi may well extend its activities in the promotion of scientific research to universities outside the borders of the United States.

2. The establishment of chapters in industrial organizations with research laboratories as well as in educational institutions. Already the Executive Committee is studying that important subject.

3. Seeking and discovering young research workers of promise, and offering the financial assistance of the Society in the pursuance of their projects, rather than limiting its grants-in-aid to those who apply for them.

4. Broadening the scope of its present definitions of eligibility to membership to include research workers in all fields, in the so-called arts as well as in the sciences, thus making the object of the Society to encourage original investigation, not exclusively investigation in science, pure and applied.

(*Please turn to page 40*)

REPORT OF THE TREASURER FOR 1939

BALANCE SHEET AS AT DECEMBER 31, 1939

ASSETS

Cash:		
Checking account	$ 6,558.99	
Custodian account	9,475.00	
		$16,033.99
Securities owned—(carried at cost) (see schedule following)		26,999.29
		$43,033.28

FUNDS

General Funds:		
Cash and securities carried at cost	$28,161.34	
Semi-Centennial Fund	15,050.00	
		$43,211.34
Less: Alumni Fund—Deficit		178.06
		$43,033.28

TOTAL RECEIPTS AND DISBURSEMENTS FROM ALL SOURCES AND FUNDS

(All assessments and initiation fees were paid by the chapters, before the end of 1939, except assessments on the chapters at California Institute of Technology, McGill University, and University of Oregon, and initiation fees at McGill University.)

RECEIPTS

Cash on hand, December 31, 1938	$ 7,333.02	
Chapter assessments for 1939	8,471.25	
Chapter assessments for 1938, arrears	98.20	
Chapter assessments for 1940, advance	5.00	
Initiation fees for 1939	2,865.25	
Initiation fees for 1938, arrears	200.00	
Installation fees	100.00	
Sale of insignia, 1938	300.00	
Securities redeemed	9,475.00	
Interest on investments	1,117.09	
Lecturers' stipends	2,025.00	
Gift	100.00	
Alumni contributions for research	1,718.02	
Overpayments	145.00	
		$33,952.83

DISBURSEMENTS

Secretary's office (total $4,908.51)		
Assistants	$ 2,652.00	
Office supplies, stamps, etc.	456.51	
Secretary's stipend	1,800.00	
Treasurer's office (total $241.19)		
Assistant	150.00	
Postage, supplies, etc.	25.14	
Auditing 1938 books	20.00	
Custodian account	33.55	
Treasurer's bond	12.50	
Officers' traveling expenses	1,430.37	
QUARTERLY (3 issues)	2,336.32	
Circularization of alumni for research contributions	963.63	
Engrossing chapters	96.35	
Lecturers' stipends	1,975.00	
Lecturers' expenses	1,908.89	
Science Service	200.00	
Grants-in-aid of research 1938-39	1,025.00	
Grants-in-aid of research 1939-40	2,030.00	
Books, Science in Progress for alumni contributors	658.58	
Return of overpayments	145.00	
		$17,918.84
Cash on hand, December 31, 1939:		
Corn Exchange Bank Trust Co.—Checking account	$ 6,558.99	
Corn Exchange Bank Trust Co.—Custodian account	9,475.00	
		16,033.99
		$33,952.83

OPERATING STATEMENT FOR 1939

FOR GENERAL CONDUCT OF THE SOCIETY

(Partly estimated and not included in audit)

INCOME

Chapter assessments for 1939	$ 8,857.00	
Initiation fees for 1939	3,023.25	
Installation fees	100.00	
Sale of insignia	1,500.00	
Interest	515.09	
		$13,995.34

EXPENDITURES

Secretary's office	$ 5,230.01	
Treasurer's office	241.19	
Officers' traveling expenses	1,491.58	
QUARTERLY (4 issues)	2,937.05	
Circularization of alumni for research contributions	801.04	
Engrossing charters	96.35	
Lecturers' expenses	1,908.89	
Science Service	200.00	
		$12,906.11
Operating surplus for the year		$ 1,089.23

GEORGE B. PEGRAM, *Treasurer.*

ALUMNI FUND FOR RESEARCH

RECEIPTS

*Cash on hand, December 31, 1939	$ 1,215.50	
Receipts from contributions by alumni members, less cost of copies of book, Science in Progress, sent to alumni members ($1,718.02—$658.58)	1,059.44	
Interest on Semi-Centennial Fund allocated to Alumni Fund (Ex. Com. Minutes, April, 1939)	602.00	
		$ 2,876.94

DISBURSEMENTS

Payments on grants for research:

1938-39		
G. W. Kidder	$ 100.00	
Alfred Perlmutter	150.00	
W. P. Spencer	250.00	
C. H. Brown	100.00	
K. B. Kraushopf	50.00	
E. A. Fath	175.00	
D. C. Carpenter	200.00	
		$ 1,025.00
1939-40		
B. G. Shafiroff	$ 100.00	
Max Demorest	150.00	
R. M. Reinecke	180.00	
Elmer R. Noble	100.00	
John B. Buck	100.00	
Franklin E. Roach	200.00	
Reginald D. Manwell	200.00	
G. Z. Dimitroff	250.00	
C. Donnell Turner	200.00	
Walter Landauer	350.00	
G. W. Kidder	200.00	
		$ 2,030.00
		$ 3,055.00
*Deficit, December 31, 1939		178.06
		$ 2,876.94

* This is included in total cash on hand, page 36.

SEMI-CENTENNIAL FUND

PRINCIPAL ACCOUNT

Net amount for contributions, January 1, 1938	$11,865.57	
Additional contributions received to April 12, 1938	160.67	
Appropriated by the Ex. Com. from funds of the Society, April 27, 1938	2,973.76	
Gift	50.00	
		$15,050.00
The Semi-Centennial Fund, in accordance with resolutions of the Executive Committee, now represented by $15,050 of the market value of the securities owned by the Society, which securities now have a market value above $20,000		$15,050.00

INTEREST ACCOUNT

In accordance with resolution of Ex. Com. April, 1938, interest on the $15,050 Semi-Centennial Fund was apportioned at the rate of 4%	$ 602.00
In accordance with the same resolution above interest apportioned to the Semi-Centennial Fund has been used for direct aid to research through the Alumni Fund for Research	602.00

INVESTMENT ACCOUNT

SCHEDULE OF SECURITIES OWNED, CARRIED AT COST

$1,000 Amer. Tel. & Tel. Co. 5½% (1943) bond at	$ 991.94
$1,000 St. Louis & San Francisco Railway 4% (1950) bond at (certificate of deposit)	796.33
$1,000 Baltimore & Ohio Railway 5% (2000) bond	955.00
$1,000 Philadelphia Company 5% (1967) bond at	979.50
$1,000 Erie Railroad Company 5% (1967) bond at	947.00
$1,000 Southern Railway Company 6% (1956) bond at	1,152.00
$1,000 Philadelphia Company 5% (1967) bond at	997.00
$1,000 Canadian Pacific 5% (1954) bond at	1,010.00
$1,000 U. S. Treasury 4% (1954) bond at	999.06
$1,000 U. S. Treasury 3% (1955) bond at	942.50
$1,000 U. S. Treasury 3% (1955) bond at	942.50
$1,000 U. S. Treasury 3% (1955) bond at	942.50
$1,000 U. S. Treasury 3⅛% (1946/49) bond at	1,069.07
$1,000 U. S. Treasury 3⅛% (1946/49) bond at	1,069.06
$1,000 U. S. Treasury 3⅛% (1946/49) bond at	1,069.06
$ 200 New York City 4% (1940) bond at	198.50
$ 200 New York City 4% (1941) bond at	198.50
$ 200 New York City 4% (1942) bond at	198.50
$ 200 New York City 4% (1943) bond at	198.50
$1,000 Southern California Edison Co. 3¾% (1960) bond at	1,065.00
$1,000 Southern California Edison Co. 3¾% (1960) bond at	1,065.00
$1,000 Consumers Power Co. 3½% (1965) bond at	1,057.50

$1,000 Consumers Power Co. 3½% (1965) bond at	1,057.50
$1,000 Edison Elec. & Illum. Co. 3½% (1965) bond at	1,071.25
$1,000 Edison Elec. & Illum. Co. 3½% (1965) bond at	1,071.25
$1,000 Consolidated Edison Co. 3¼% (1946) bond at	1,047.50
$1,000 Consolidated Edison Co. 3¼% (1946) bond at	1,047.50
$1,000 Consolidated Edison Co. 3¼% (1946) bond at	1,047.50
$1,000 Southern Pacific Co. 4½% (1969) bond at	905.75
$1,000 Southern Pacific Co. 4½% (1969) bond at	907.00
	$26,999.29

All companies continue to pay interest on their bonds except the St. Louis & San Francisco Railway, which is in receivership, the Erie Railroad Company and the Baltimore & Ohio Railway (paying in part only).

SCHEDULE OF SECURITIES REDEEMED IN 1939

$1,000 U. S. Treasury 2⅛% (1939) bond redeemed at	$ 1,000.00
$1,000 U. S. Treasury 2⅛% (1939) bond redeemed at	1,000.00
$1,000 U. S. Treasury 2⅛% (1939) bond redeemed at	1,000.00
$1,000 U. S. Treasury 2⅛% (1939) bond redeemed at	1,000.00
$1,000 U. S. Treasury 2⅛% (1939) bond redeemed at	1,000.00
$1,000 U. S. Treasury 2⅛% (1939) bond redeemed at	1,000.00
$ 200 New York City 4% (1938) bond redeemed during 1938 at	200.00
$ 200 New York City 4% (1939) bond redeemed at	200.00
$1,000 General Motors Acceptance Co. 3% (1946) bond redeemed at	1,025.00
$1,000 General Motors Acceptance Co. 3% (1946) bond redeemed at	1,025.00
$1,000 General Motors Acceptance Co. 3% (1946) bond redeemed at	1,025.00
See Cash Receipts—Securities Redeemed	$ 9,475.00

GEORGE B. PEGRAM, *Treasurer.*

January 26, 1940.

AUDITORS' STATEMENT

We have audited the accounts of the Treasurer of the Sigma Xi Society for the year ending December 31, 1939, and have found that all income as contained in the records was duly accounted for and that disbursements were supported by proper vouchers. The securities listed above were verified by certificates from the Custodian, namely, The Corn Exchange Bank Trust Company. We certify that the foregoing statements of Assets, Funds, Income and Disbursements are correct and fairly present the operations for the year and the financial position of the Society as of December 31, 1939.

J. T. FINNERAN,
FRANK X. FARR,
Auditors.

January 31, 1940.

REPORT OF COMMITTEE ON SIGMA XI QUARTERLY

To review briefly the developments since the committee meeting in New York, April 1, 1939.

Our report, in which we recommended changes in policy and scope for the QUARTERLY, was presented to the Executive Committee of Sigma Xi at its meeting in April. The recommendations were adopted and the committee was requested to proceed to formulate the details of the proposed plan and select an editorial board for nomination to the Executive Committee at its meeting next December. It was understood that if the Convention approves the proposed plan, the Executive Committee should then formally appoint the editorial board so that the project could be started with the first issue of 1940.

Subsequent to the April meeting of the Executive Committee, as chairman of the Committee on the QUARTERLY, I have had several conversations and exchange of letters with various officers of Sigma Xi and with others interested in the QUARTERLY. It now seems desirable for us to proceed a little more slowly in the development of the general plan for an enlarged QUARTERLY. It would perhaps be rather difficult in the short time between the formal acceptance of the plan at the December meeting and the issuing of the first number of 1940 to put the plan in full operation, unless we were to presume on the prerogatives of the Convention and get the editorial board unofficially appointed and at work and thereby request the Convention to "sign on the dotted line." Not only does this seem unwise but we will probably gain in the long run by starting the plan somewhat more gradually.

President Baitsell and I took the occasion of being together in Boston some weeks ago to discuss the whole proposal. He and I wish to make the following suggestions to the QUARTERLY Committee:

1. That for the time being—say for a couple of years—the editing of the QUARTERLY be associated, as in the past, with the Secretary's office, the Secretary being in effect editor-in-chief.

2. That there be chosen by the Executive Committee, on nomination from the QUARTERLY Committee an editorial board composed substantially as follows:

An Editor-in-Chief (The Secretary).

Three editors at large.

(We suggest Dr. Watson Davis, representing Science Service; Dr. F. R. Moulton, representing A. A. A. S. and the *Scientific Monthly*; and some such science writer as Waldemar Kaempfert or Howard Blakeslee.)

Twelve associate editors representing respectively the following branches of science:

Physical Sciences	*Biological Sciences*
Mathematics	Botany
Astronomy	Zoology
Physics	Genetics
Chemistry	Agricultural Sciences
Earth Sciences	Psychology
Engineering	Medical Sciences

One or more associate editors representing the alumni.

3. That during this two-year period of expansion, the Editor-in-Chief, with the assistance of the editorial board gradually put into operation the program which the Committee on the QUARTERLY has proposed. As early as possible, the Editor-in-Chief would request each of the associate editors to secure from some competent writer in his field a survey article written for the general scientific public, there being an honorarium of, say, $50 to $75 for each such article, to be paid out of current Sigma Xi funds. It would be the duty of the associate editor to see to it that the article is written at the appropriate "level" and to give the manuscript general editorial consideration before passing it on to the Editor-in-Chief.

4. That, if possible, two such articles, one from Physical Sciences and one from Biological Sciences, be included in each issue. (If each associate editor serves for three years he would assume responsibility for two such articles during his term of office.)

Except for the establishment of an editorial board and the payment of honoraria to authors of invited articles, the above plan makes no major change at the moment in the operation of the QUARTERLY. It does permit the gradual transition from the present QUARTERLY to the enlarged QUARTERLY proposed by the Committee. If the plan proves successful during this transition period, an Editor-in-Chief could then be selected and the Secretary relieved of further responsibility. With several issues of the QUARTERLY in hand, containing the broad survey articles contemplated, the Society would be in a much stronger position to go to the alumni to solicit subscriptions and support than would be the case at present. Now we would have only hopes and plans to offer to the alumni. After two years, we would have a definite accomplishment as a basis for a subscription campaign. The cost to the Society during this two-year period might be a little greater than was at first contemplated but we believe that it would be a good investment in the long run.

F. K. RICHTMYER, *Chairman.*

THE MEMBERSHIP STRUCTURE OF SIGMA XI

AN INTRODUCTION TO A STUDY OF ITS EFFECTIVENESS

Sigma Xi was founded as an honorary society for students in science, election to which would carry the prestige that Phi Beta Kappa carried for students receiving high marks in letters and arts.

The object of this Society has always been "to encourage original investigation in science pure and applied" and an important means of attaining this end has been "granting the privilege of membership to such students as have, during their college course, given special promise of future achievement." This latter quotation appeared in the Constitution of the Society up to 1922 when it was placed in an Appendix.

Early in the life of the Society, its leaders came to the conclusion that "marks" gained in recitations and examinations were not evidence of promise of ability to discover truth or to conduct original research successfully.

At the close of the first quarter century of the life of the Society, the more general acceptance of science in education and industry, the increase of graduate study in science and the growth of the Society gave rise to discussion of the problem of measuring membership qualifications and led to the establishment of a new grade designated the "Associate."

The following paragraphs from the "Second Quarter Century History of the Society" summarize the actions taken:

> Eligible to membership in the Society of the Sigma Xi, as defined in the Constituton up to 1911 and a few years thereafter, were: (a) Professors or instructors of the institution where there were chapters who had shown noteworthy achievement as original investigators in some branch of pure or applied science; (b) any resident graduate who had by actual work exhibited an aptitude for scientific investigation; and (c) any undergraduate in the fourth-year class, or in a class substantially equivalent thereto, who had given promise of marked ability in those lines of work which it was the object of the Society to promote. Chapters were also empowered by the Constitution to elect as non-resident members professors or instructors or investigators connected with neighboring educational, scientific or professional institutions not having a chapter, who would otherwise be eligible for active membership.
>
> At the Convention of the Society held in Cleveland, January 2, 1913, a committee was appointed "to formulate an amendment to the Constitution defining the qualifications for membership and associateship in the Society." The action was the culmination of a discussion that had been going on for several years regarding two classes of members. It appeared to many members of the Society that a distinction should be made between candidates who had actually engaged in research and candidates who had excelled in scientific work but had not carried on original investigations. In December of that year (1913) it was proposed to define eligibility to associateship in

the Society as based upon "promise of marked ability or evidence of marked excellence in those departments of science which it is the object of the Society to promote." After three years of discussion, through the official journal (THE SIGMA XI QUARTERLY) and in the intervening Conventions, the Convention of 1916 approved the proposal to make optional with the chapters the election of students to associateship, and eligibility of graduate students was based upon "marked excellence in one or more departments of pure or applied science," and of undergraduate students, upon "three years of required work and marked excellence in two or more departments of pure or applied science." In 1922 the Convention of the Society voted definitely to limit election of undergraduates to associateship in all chapters installed after that date. Hence the charter of all chapters organized since 1922 contain the phrase, "provided the chapter shall have power to elect undergraduates to associate membership only."

Of the thirty-eight chapters established prior to 1922 which according to the Constitution have the privilege of deciding whether they will elect undergraduates as associates or not, twenty-nine elect undergraduates as associates.

In the Constitution of 1914, there was a provision for the election of honorary members by three-fourths vote of the annual Convention. Scientific workers who have achieved eminence in some branch of pure or applied science were to be selected for this distinction. The Secretary reports that the records show that only a few were elected under this provision.

The general scheme of Sigma Xi membership and its usefulness in advancing the object of the Society is again under discussion and the President, at the instance of the 1938 Richmond Convention, appointed a committee to consider the entire problem and report at some future Convention.

The committee consists of R. T. Birge, Berkeley, California; F. B. Dains, Lawrence, Kansas; C. E. McClung, Philadelphia, Pennsylvania; P. F. Sharp, Ithaca, New York; L. L. Woodruff, New Haven, Connecticut; and C. E. Davis of New York, New York, as chairman. F. F. Dedrick of New York, New York, has accepted appointment as secretary.

In general, the committee has the problems (1) of studying the membership structure of Sigma Xi and its administration in the seventy-eight chapters of the Society; (2) of reaching conclusions as to its suitability to advance the object of the Society under the present and probable future trends of research in this country; and (3) the recommendation of policies relating to membership that will make our Society more useful in attaining its principal objective—that of encouraging original investigation in science pure and applied.

Some of the factors prompting this study or to be taken into consideration during the study are as follows:

1. The lack of uniformity among the chapters in administering the membership requirements. Some chapters elect only graduates. Other chapters are at schools that give no graduate work in science. A few chapters elect undergraduates to the member grade.

2. There is some dissatisfaction with the associate grade and the fact that it does not carry voting privileges.

3. The institution of higher grades such as fellow or honorary member has been urged.

4. The establishment of a paid-up alumni grade to be known as life member has been suggested.

5. The establishment of chapters at industrial research laboratories has been suggested.

6. The definitions of the duties and privileges of chapter membership and alumni membership need restatement.

7. The number of honorary societies has grown greatly. Phi Beta Kappa now elects undergraduates in science. What is to be the effect on Sigma Xi?

In tackling this problem it seems obvious that some general principles can be accepted:

First. The selection of worthy individuals on some basis easy of administration on a national scale is an important function of the Society.

Second. The chapters shall have complete jurisdiction in determining whether candidates meet the qualifications laid down.

Third. The policy of selection should be as nearly uniform among the Chapters as is practicable.

The purpose of this memorandum is to introduce the problem to the chapters, to request their wholehearted cooperation in the study and to arouse any comments about the scope or direction of the study that will aid it or insure its success.

C. E. DAVIES, *Chairman.*

Report of the Secretary for 1939

(*Concluded from page 34*)

5. A closer relation of Sigma Xi clubs to the national organization. This movement is already in progress, and clubs organize now only under definite authority of the Executive Committee. A possible next step in this movement will be the registration of enrollment of club members in the office of the National Secretary, the levying of some kind of tax, and the distribution of the official journal to the membership.

6. A central headquarters of the national organization, with a full-time Secretary and adequate clerical force. With the growth of the organization and the expansion of its movements in the promotion of research, the demands upon the Secretary's office have multiplied enormously. It is becoming increasingly difficult each year to carry the work of the office and at the same time discharge professorial duties.

These are not simply possibilities that may or may not be realized in a more or less distant and dim future. They are probabilities, some of them already in the offing. You will see some of them, and others, as the years pass.

Growth is inevitable where there is life. The Society of the Sigma Xi is a living organism.

EDWARD ELLERY, *Secretary.*

SIGMA XI LECTURE SERIES FOR 1940

Lecturers, lectures, and available dates of the third series of Sigma Xi lectures are announced by the Committee on Lectures as follows:

Lecturer: Professor F. W. Went.
Topic: The Regulations of Plant Growth.
Available Dates: Last two weeks in January.

Professor Went is Professor of Plant Physiology at the California Institute of Technology. He came to the Institute in 1933 from the Botanical Gardens of Buitzenorg, Java, where he had been Director of the Foreigners Laboratory. His research work has been done in plant hormones, plant growth, phototropism, root formation, polarity, the water relation of plants, ecology of spiphytes.

Lecturer: Professor J. F. Fulton, M.D.
Topic: The Functions of the Frontal Lobe; an Experimental Analysis in Monkeys, Chimpanzees and Man.
Available Dates: First two weeks in February.

Doctor Fulton is Sterling Professor of Physiology, in the School of Medicine of Yale University. His experience includes association with Magdalen College of Oxford University, and with the Peter Bent Brigham Hospital in Boston. His investigations cover the blood pigments of invertebrates, especially of Ascidians, the nature and significance of the electrical response of contractile tissues, the reflex coordination of movement and posture, and the comparative physiology of the primate brain.

Lecturer: Professor J. W. Beams.
Topic: High Speed Centrifuging.
Available Dates: First two weeks in March.

Professor Beams is Professor of Physics at the University of Virginia His researches include the measurement of very short time intervals, the Keer effect, electrical discharges, and ultra-centrifuges.

Lecturer: Professor Douglas Johnson.
Topic: Mysterious Craters of the Carolina Coast.
Available Dates: Last two weeks of March.

Professor Johnson is Professor of Physiography at Columbia University and Executive Officer of the Department of Geology and Mineralogy. He has filled national and international positions of importance. He has been connected with the United States Geological Survey, and has been geological adviser of the United States Department of State. He was Consulting Physiographer for the Canadian Government in the Labrador boundary dispute. He has been awarded medals by many societies in this country and Europe. His researches include the physiography of lands, shore-line physiography and military geography.

Lecturer: Dr. D. A. MacInnes.
Topic: The Motions of Ions and Proteins in Electric Fields.
Available Dates: Last two weeks of April.

Doctor MacInnes is associated with the Rockefeller Institute for Medical Research in New York City, and was formerly Associate Professor of Physical Chemistry at the Massachusetts Institute of Technology. His research work has been done in the field of solutions of electrolytes and of electrochemistry.

CHAPTER OFFICERS

List Furnished by the Secretaries of the Chapters

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OFFICIAL ANNOUNCEMENTS

SIGMA XI EMBLEMS

All insignia of the Society are available only through the office of the National Secretary. They are made in various styles and sizes, and in white and yellow gold. Orders for these insignia are issued through chapter secretaries, and must be *prepaid*. Information about styles and prices may be obtained from chapter secretaries or the National Secretary.

DIPLOMAS FOR MEMBERS AND ASSOCIATES

These diplomas are available in any quantity at 10 cents each. Diplomas can be engraved with the name of the individual and of the chapter and the date of initiation at 25 cents each. Orders should be sent to the National Secretary, should specify whether for members or associates, and should be accompanied by check.

INDEX CARDS

Index cards for newly elected members and associates are available *gratis* upon requisition from chapter secretaries to the National Secretary. These cards should be made out in duplicate, one set being retained for chapter files and one set being sent to the National Secretary for filing in the permanent records of the national organization.

NATIONAL CONSTITUTION

Printed copies of the National Constitution and History of the Society are available at 5 cents each from the National Secretary.

CHANGES OF ADDRESSES

Chapter secretaries are asked to send to the National Secretary in October of each year changes in their enrollment lists as follows: 1. Names and addresses to be deleted from the previous list; 2. Names and addresses to be added to previous list; 3. Changes of addresses of those on previous list who may have moved to a new address since the list was submitted.

SIGMA XI STATIONERY

Stationery in the official color of the Society is now available for all chapters and clubs at $5 per 500 sheets and $5 per 500 envelopes. The letter sheets bear the Society's seal embossed in white but no printing. The envelopes are the official square envelopes used by the national officers. Printed heading on the sheets and printed corner cards on the envelopes can be provided at cost, when so desired.

EDWARD ELLERY,
National Secretary, Sigma Xi,
Union College,
Schenectady, N. Y.